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A Survey of Aquatic Macrophytes and Water Quality in Max, William, Adam, Bower, Sharpe and Metigoshe Lakes

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A Survey of Aquatic Macrophytes and Water Quality in Max, William, Adam, Bower, Sharpe and Metigoshe Lakes.

C. Hughes

Water Standards and Studies Section,
Environmental Management Services Branch,
Environmental Management Division,
Manitoba Department of Environment and
Workplace Health and Safety

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ABSTRACT

On August 11 and 12, 1981 a survey of emergent and submergent vegetation and water chemistry was carried out on six lakes in the Turtle Mountain Provincial Park area. The survey was conducted in response to complaints about aquatic macrophyte (weed) growth on Max Lake. William, Adam, Bower, Sharpe and Metigoshe Lakes were included in the survey. Historical data were limited and no conclusions could be drawn regarding the causes for an unusually heavy growth of macrophytes on Max Lake. Also, it could not be determined if there were unusually heavy growths of macrophytes in the other lakes. There was, however, a heavy algae bloom in Bower Lake which may have been in the process of dying off and using up oxygen in the middle and lower portions of the water column. It was also possible that some sewage may have been present in Bower Lake. Two dead Walleye Stizostedion vitreum were noted in Max Lake and it was probable that these fish died in a "summer kill" created by the dying off of a previous algae bloom.

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INTRODUCTION

In response to complaints about aquatic macrophyte (weed) growth in Max Lake, surveys of emergent and submergent vegetation and water chemistry were carried out in six lakes in the Turtle Mountain Provincial Park area on August 11 and 12, 1981. Lakes surveyed included William (49°02 N 99°59W), Adam (49°02 N 100°04 W), Bower (49°03 N 100°04 W), Max (49°04 N 100°39 W), Sharpe (49°03 N 100°20 W), and Metigoshe (49°00 N 100°22 W).

METHODS

The type and distribution of emergent and submergent aquatic vegetation was mapped and physical and chemical data were collected at one water chemistry station on each lake. With two exceptions, aquatic vegetation was mapped by using a boat with an outboard motor to cruise the shoreline of each lake and estimate:

the extent of areas occupied by vegetation in general;

the area and location of dense weed beds; and

the predominant vegetative type.

Vegetation in the south basin of Sharpe Lake and the north (Canadian) portion of Metigoshe Lake was estimated from shore. At the water chemistry stations, some physical and chemical parameters were measured at one metre intervals through the water column. This includes temperature, conductivity (top to bottom), pH measurements and dissolved oxygen samples, (top to one metre off the bottom). Water samples for chemical analyses were obtained (top, middle and approximately one half a metre above the bottom) and were

subsequently analyzed at the Technical Services Laboratory for conductivity, non-filterable residue, pH, total organic carbon, total inorganic carbon, total nitrogen, ammonia, nitrate and nitrite and total phosphorus (Sorba et al, 1980). Surface water samples were analyzed at Cadham Provincial Laboratory for total and faecal coliform bacteria.

RESULTS AND DISCUSSION

A. Aquatic Macrophytes

The predominant macrophytes in all six lakes included the emergent bulrush (Scirpus sp.) and the submergent milfoil and pond weed (Myriophyllum spp. and Potamogeton spp.) (Table 1). Emergent vegetation was generally restricted to the shoreline and the only lake where emergent vegetation may have presented a problem was in Sharpe Lake, where bulrushes blocked off a narrow channel between the north and south basins, (Figure 1). On some of the lakes, dense submergent weed beds appeared to restrict the use of power boats and make access to launching facilities and cottage lots difficult.

Submergent aquatic vegetation would not have significantly affected swimming and boating in William, Bower and Adam Lakes. Aquatic vegetation occupied approximately 20% and 10% of the surface areas of William and Bower Lakes, respectively, and dense submergent weed beds were restricted to shallow bays in both lakes (Figure 1). Although dense weed beds occupied approximately 50% of the surface area of Adam Lake, boating was not encouraged on the lake (no launch facilities). The swimming area was separated from the rest of the lake by a dike (Figure 1) and had been treated with copper sulphate to reduce algae blooms.

TABLE 1 Major genus and/or species of emergent and submergent rooted aquatic vegetation and their relative importance at each of six lakes in the Turtle Mountains, August 11 and 12, 1981.

		Lake/Relative Importance [A]					
		Willis	Adam	Bover	Max	Sharpe [B]	Metigoshe
Emergent Vegetation							
Bulrush	*Scirpus* sp.	1	1	1	1	1	1
Reed Grass	*Phragmites* sp.	3		4	3		
Cat Tail	*Typha* sp.		4	3		4	1
Sweet Flag	*Acorus Calamus*		4	4		3	
Sedge	*Carex* spp.					3	
Spike Rush	*Elocharis* spp.			4			
Arrowhead	*Sagitaria* spp.			4		4	
Submergent Vegetation							
Milfoil	*Myriophyllum* spp	1	1	1	1	1	1
Pondweed	*Potamogeton richardsonii*	2	2		3		
	P. filiformis	2		4	3	3	3
	P. pectinatus	2					
	P. vaginatus		4				
	P. zosteriformis		2		3		
	P. friesii				3		
	P. natans				4		
Common Elodea	*Elodea canadensis*						4

A. Relative importance indicates: 1 as predominant or codominant at 40% or more of vegetation (either emergent or submergent); 2 as subdominant at 20 to 40%; 3 as subdominant, in the absence of 2, at 10 to 20% and 4 at less than 10%.

B. Estimated vegetation by observations from shore for the south basin of Sharpe Lake and Metigoshe Lake.

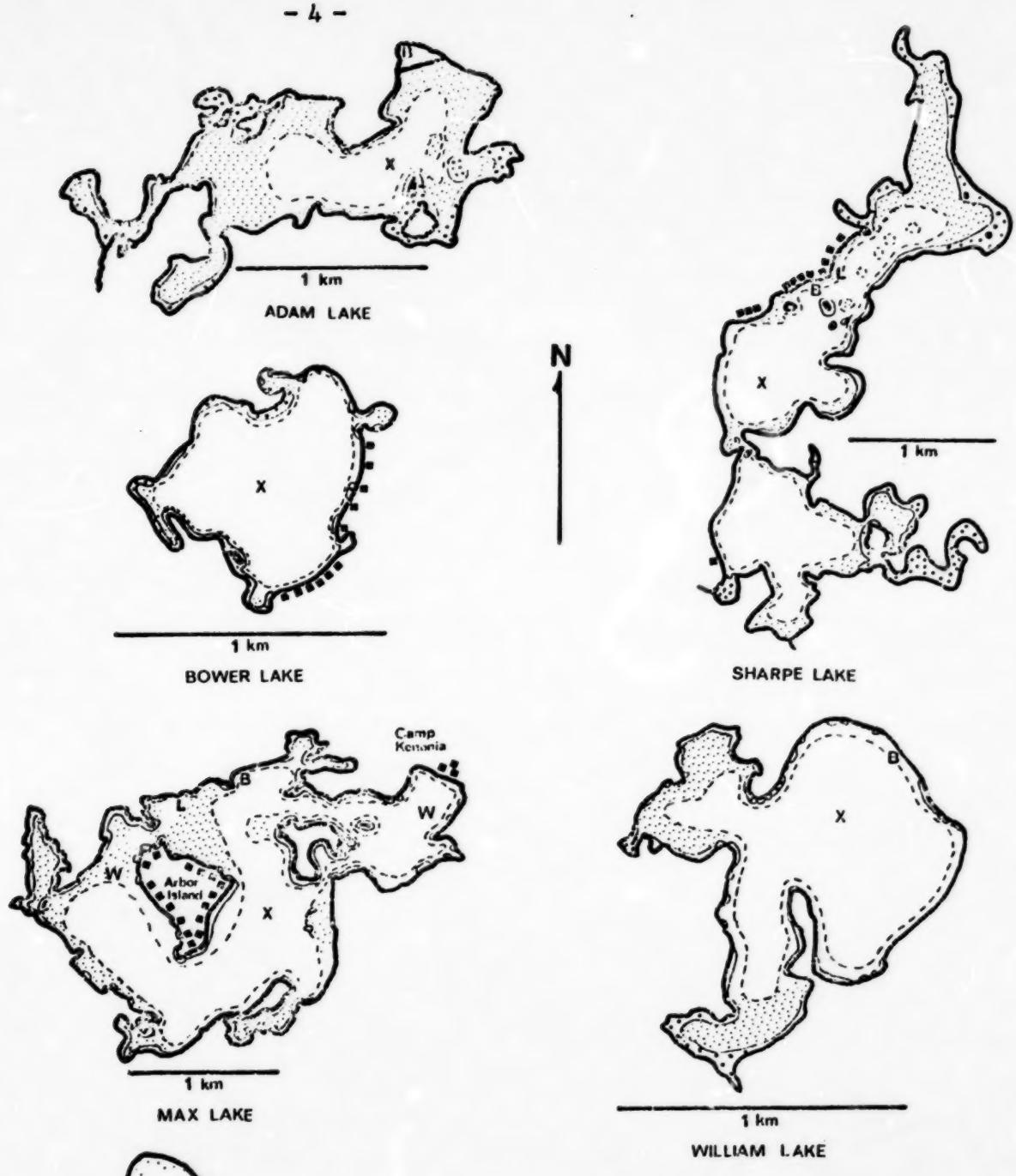

FIGURE 1: Aquatic vegetation and water chemistry stations, Turtle Mountain Lakes, August 11 and 12, 1981

Submergent aquatic vegetation appeared to be a nuisance in Sharpe Lake, but did not appear to prevent boating and swimming activities in the immediate vicinity of the north basin cottage development. Approximately 25% of the surface area of the north basin of the lake was occupied by aquatic vegetation. Dense submergent weed beds were generally restricted to areas where the depth was two metres or less. The narrow channel between the north and south basins was occupied by a dense growth of emergent and submergent vegetation and this prevented motor boat access to the south basin. The channel had been occupied by dense weed growth in August and September, 1979, and water levels were higher and therefore the channel could be navigated with some difficulty. Weed beds in the south basin were observed from the channel and the west shore. They appeared to generally have developed in areas previously noted by Beck and the author (1979), to be two metres or less in depth. The area occupied by submergent and emergent vegetation appeared to encompass approximately 25% of the area occupied in the north basin.

Aquatic vegetation occupied approximately 30% of the surface area of Max Lake. Submergent weed beds were relatively dense between the boat launch facility and Arbor Island, but relatively sparse in the beach area and at Camp Koinonia (Figure 1). The dense weed growth between Arbor Island and the mainland would have created considerable problems for people commuting between the boat launch and cottages on the Island by fouling the propellers of outboard motors. Weed beds were denser earlier in the summer of 1981. Between Arbor Island and the boat launch, the weed beds were apparently considerably more dense than had been noted in past years (Howard, personal

communication, 1981). Water in the east bay may have been treated with copper sulphate since there were few rooted aquatic plants in the vicinity of Camp Koinonia and a minor algae bloom apparent in the rest of the lake was not evident.

The density and location of submergent weed beds in the Canadian portion of Metigoshe Lake was estimated by observations made from shore. The bottom of the lake appeared to be covered by a growth of milfoil and weed beds were observed to surface along the shoreline and in patches at the centre of the lake. Virtually the entire Canadian shoreline was developed for cottages and the abundance of submergent vegetation along the shoreline would have restricted boating and swimming. It should also be noted that weeds in this area had been cut on a number of occasions prior to August 12. This was done with an aquatic weed harvester used by the operator of the Holiday Hills Resort.

B. Water Quality

Algae blooms and dead fish were noted during August 11 and 12, 1981. A heavy algae bloom on Bower Lake August 11 reduced the Secchi disc transparency to 0.25 m. This bloom may already have peaked and started to die off since the level of dissolved oxygen in the lower half of the water column was considerably less than in the surface water or in the entire water columns of each of the other lakes tested (Table 2). A somewhat lighter algae bloom was in progress on Max Lake where the Secchi disc transparency was 1.00 m. On August 12, two dead walleye, Stizostedion vitreum, were noted in Max Lake (Figure 2). Although oxygen levels were supersaturated at the time of the

survey, it was possible that the fish had died in a "summer kill" caused by depletion of oxygen during the die off of a previous algae bloom.

Dissolved oxygen levels in August 1981 were generally good in each of the lakes tested excepting Bower Lake. The surface water in Bower Lake was relatively well oxygenated as dissolved oxygen levels at the surface and one metre below the surface were 8.7 and 8.1 mg/l, respectively (23 to 23.5°C). However, at two and three metres below the surface, dissolved oxygen levels were 5.7 mg/l at 22°C and 4.1 mg/l at 21.25°C respectively (Table 2). Some degree of thermal stratification was apparent in each of the other lakes but oxygen levels did not appear to be particularly depleted near the bottoms. Dissolved oxygen levels ranged from 6.8 to 11.6 mg/l (Table 2), well above the limit of 5.0 mg/l suggested for healthy fish life (Ellis et al., 1946).

Field tested pH ranged from a low of 7.95 at the bottom of Bower Lake to a high of 9.94 at surface of Sharpe Lake. Mean laboratory tested pH ranged from 8.23 in Bower Lake to 9.95 in Sharpe Lake (Tables 2 through 8). Although the soils in south western Manitoba are somewhat alkaline, the pH levels noted on August 11 and 12, 1981 appeared to have been unusually high. Excepting Bower and William Lakes, all the lakes averaged over 9.0 pH units (Tables 3 through 8). (It should be noted that the mean pH in Sharpe Lake tested in June, July, August and September 1979 was considerably lower at 8.15 pH units (Beck and Hughes, 1979).) Should a pH of 9.0 or more persist in these lakes, irritation to swimmers eyes will occur and the elimination of viable cold water fisheries and reduction of warm water fisheries may occur. (Committee on Water Quality Criteria, 1972; McKee and Wolfe, 1963).

TABLE 2: Physical and Chemical Parameters, Field Tests, Turtle Mountain Lakes, August 11 and 12, 1981.

Lake	Date	Depth m	pH Units	Temperature °C	Conductivity * umhos/cm	Dissolved Oxygen mg/l	Oxygen Saturation
William	August 11	0	8.98	22.5	380	7.8	90
		1	8.94	22.5	386	8.1	94
		2	8.90	21.5	388	7.6	86
		3	8.93	21.5	387	8.0	90
		4	8.93	21.5	387	7.7	87
		5	8.91	21.5	393	6.9	78
		6	8.90	21.5	396	6.8	77
		7	Bottom	20.5	404	-	-
Adam	August 11	0	9.80	23.0	270	8.6	100
		1	9.79	23.0	270	8.6	100
		2	9.78	22.0	273	9.2	105
		3	9.77	21.0	279	8.0	89
		4	Bottom	20.75	284	-	-
Bower	August 11	0	8.60	23.5	324	8.7	103
		1	8.48	23.0	323	8.1	94
		2	8.25	22.0	330	5.7	65
		3	7.95	21.25	334	4.1	45
		4	Bottom	21.0	346	-	-
Max	August 12	0	9.70	22.0	365	11.6	132
		1	9.74	22.0	365	11.3	129
		2	9.74	22.0	366	11.0	126
		3	9.78	20.0	367	10.9	119
		4	Bottom	20.0	381	-	-
Sharpe	August 12	0	9.94	22.5	401	11.0	126
		1	9.92	22.5	401	10.7	123
		2	9.91	22.0	404	10.2	115
		3	Bottom	21.5	399	-	-
Metigoshe	August 12	0	9.34	24.0	419	10.8	128

* Conductivity at S.T.P.

TABLE 3 : Physical and Chemical Parameters, Laboratory Analyses
William Lake, August 11, 1981

Parameter	Top	Middle	Bottom	Mean ± S.D.
Conductivity (umhos/cm)	384	387	386	385.7 ± 1.5
Non Filterable Residue (mg/l)	8	20	15	14.3 ± 6.0
pH (Units)	9.00	9.00	8.95	8.98 ± 0.03
Total Organic Carbon (mg/l)	20.0	23.0	22.0	21.7 ± 1.5
Total Inorganic Carbon (mg/l)	49.5	48.5	46.5	48.2 ± 1.5
Turbidity (NTU)	2.5	3.0	3.0	2.83 ± 0.29
Total Kjeldhal Nitrogen (mg/l)	1 3	1.4	1.4	1.37 ± 0.06
Soluble Ammonia (mg/l)	<0.02	<0.02	0.02	<0.02 ± 0
Dissolved Nitrate-Nitrite (mg/l)	<0.01	<0.01	<0.01	<0.01 ± 0
Total Phosphorus (mg/l)	0.03	0.04	0.04	0.04 ± 0.01

TABLE 4 : Physical and Chemical Parameters, Laboratory Analyses, Adam Lake, August 11, 1981

Parameter	Top	Middle	Bottom	Mean ± S.D.
Conductivity (umhos/cm)	262	262	262	262 ± 0
Non Filterable Residue (mg/l)	10	10	7	9.0 ± 1.7
pH (Units)	9.80	8.95	9.80	9.52 ± 0.49
Total Organic Carbon (mg/l)	22.5	23.0	22.5	22.7 ± 0.3
Total Inorganic Carbon (mg/l)	29.5	30.0	30.0	29.8 ± 0.3
Turbidity (NTU)	2.5	2.5	2.5	2.5 ± 0
Total Kjeldhal Nitrogen (mg/l)	1.5	1.6	1.6	1.57 ± 0.06
Soluble Ammonia (mg/l)	< 0.02	< 0.02	< 0.02	< 0.02 ± 0
Dissolved Nitrate-Nitrite (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01 ± 0
Total Phosphorus (mg/l)	0.04	0.04	0.04	0.04 ± 0

TABLE 5: Physical and Chemical Parameters, Laboratory Analyses
Bower Lake August 11, 1981

Parameter	Top	Middle	Bottom	Mean ± S. D.
Conductivity (umhos/cm)	315	317	322	318.0 ± 3.6
Non Filterable Residue (mg/l)	20	30	25	25.0 ± 5.0
pH (Units)	8.45	8.15	8.10	8.23 ± 0.19
Total Organic Carbon (mg/l)	27.0	30.0	29.5	28.8 ± 1.6
Total Inorganic Carbon (mg/l)	41.0	42.0	40.0	41.0 ± 1.0
Turbidity (NTU)	6.0	9.0	10.0	8.33 ± 2.08
Total Kjeldhal Nitrogen (mg/l)	2.4	2.6	2.8	2.60 ± 0.20
Soluble Ammonia (mg/l)	0.10	0.12	0.21	0.14 ± 0.06
Dissolved Nitrate-Nitrite (mg/l)	0.01	0.01	0.02	0.01 ± 0.01
Total Phosphorus (mg/l)	0.12	0.19	0.20	0.17 ± 0.04

Table 6: Physical and Chemical Parameters, Laboratory Analyses
Max Lake, August 12, 1981

Parameter	Top	Middle	Bottom	Mean ± S.D.
Conductivity (umhos/cm)	316	320	324	320.0 ± 4.01
Non-Filterable Residue (mg/l)	7	10	7	8.0 ± 1.7
pH (Units)	9.85	9.85	9.80	9.83 ± 0.03
Total Organic Carbon (mg/l)	27.0	27.0	26.0	26.7 ± 0.6
Total Inorganic Carbon (mg/l)	33.0	33.0	31.0	32.3 ± 1.2
Turbidity (NTU)	5.5	3.0	3.0	3.83 ± 1.44
Total Kjeldhal Nitrogen (mg/l)	2.2	2.1	2.0	2.10 ± 0.10
Soluble Ammonia (mg/l)	<0.02	<0.02	<0.02	<0.02 ± 0
Dissolved Nitrate-Nitrite (mg/l)	<0.01	<0.01	<0.01	<0.01 ± 0
Total Phosphorus (mg/l)	0.05	0.06	0.06	0.06 ± 0.01

TABLE 7: Physical and Chemical Parameters, Laboratory Analyses, Sharpe Lake August 12, 1981

Parameter	Top	Middle	Bottom	Mean ± S.D.
Conductivity (unhos/cm)	372	372	376	373.3 ± 2.3
Non Filterable Residue (mg/l)	15	20	15	16.7 ± 2.9
pH (Units)	9.95	9.95	9.95	9.95 ± 0
Total Organic Carbon (mg/l)	38.5	39.0	39.0	38.8 ± 0.3
Total Inorganic Carbon (mg/l)	28.6	29.0	26.0	27.9 ± 1.6
Turbidity (NTU)	7.0	6.0	6.0	6.3 ± 0.06
Total Kjeldhal Nitrogen (mg/l)	2.7	2.7	2.6	2.67 ± 0.06
Soluble Ammonia (mg/l)	<0.02	<0.02	<0.02	<0.02 ± 0
Dissolved Nitrate-Nitrite (mg/l)	<0.01	<0.01	<0.01	<0.01 ± 0
Total Phosphorus (mg/l)	0.07	0.07	0.07	0.07 ± 0

TABLE 8: Physical and Chemical Parameters, Laboratory Analyses
Metigoshe Lake, August 12, 1981

Parameter	Top
Conductivity (umhos/1çm)	393
Non-Filterable Residue (mg/1)	5
pH (Units)	9.4
Total Organic Carbon (mg/1)	20.5
Total Inorganic Carbon (mg/1)	33.0
Turbidity (NTU)	3.0
Total Kjeldhal Nitrogen (mg/1)	1.5
Soluble Ammonia (mg/1)	0.02
Dissolved Nitrate-Nitrite (mg/1)	0.01
Total Phosphorus (mg/1)	0.05

Conductivity, (specific electrical conductance) was measured both in the field and the laboratory. Field measurements ranged from 270 to 419 umhos/cm and laboratory measurements ranged from 262 to 293 umhos/cm for Adam and Metigoshe Lakes, respectively (Tables 2 through 8). McKee and Wolfe (1963) indicate that a conductivity of 250 to 500 umhos/cm would be rated as "good" on a relative scale.

Non-filterable residues and turbidity did not appear to be a problem in any of the lakes tested. However, in Bower Lake the mean non-filterable residue (25 mg/l) and the turbidity (8.3 ntu) were higher than in the other lakes (Tables 3 through 8). This was probably due to the heavy algae bloom on Bower Lake.

Total organic carbon and total inorganic carbon measurements were also taken during the August 1981 survey. Total organic carbon ranged from a mean of 20.5 in Metigoshe Lake to a mean of 38.8 mg/l in Sharpe Lake. Mean inorganic carbon was lowest in Sharpe Lake at 27.9 mg/l and highest in William Lake at 48.2 mg/l (Tables 3 through 8). In 1979, tests of Sharpe Lake showed a mean total organic carbon of 39.0 mg/l and a mean total inorganic carbon of 47.0 mg/l, similar to the high end of the ranges noted in 1981 (Beck, and Hughes, 1979).

Total Kjeldhal nitrogen tested in August 1981 ranged from 1.37 mg/l in William Lake to highs of 2.60 and 2.67 mg/l in Bower and Sharpe Lakes respectively (Tables 3 through 8). Excepting Lake Metigoshe, each of the lakes had been tested for total nitrogen in January, 1969 and a range of 1.43 to 2.22 mg/l was noted for William and Bower Lakes, respectively (Howard, 1981). In June 1969 total nitrogen on Lake Metigoshe was 2.0 µg/l. Comparative

data from Sharpe Lake in 1979 showed an average summer level of 2.31 mg/l of total nitrogen while levels in July were considerably higher at 3.37 mg/l (Beck and Hughes,1979). However it is not the total concentration of nitrogen but the form in which it exists that is important (McKee and Wolfe, 1963).

Nitrates, nitrites and ammonia were tested and found to be below the detection limits in all lakes excepting Bower Lake (Tables 3 through 8). Bower Lake mean nitrates and nitrites (expressed as N) were at the detection limit of 0.01 mg/l and the mean ammonia was 0.14 mg/l as N. McKee and Wolfe(1963) note that rivers known to be unpolluted have ammonia concentrations generally less than 0.20 mg/l and that while nitrates stimulate algae growth, nitrites and ammonia may inhibit it. Ammonia nitrogen concentrations in Bower Lake were highest near the bottom at 0.21 mg/l as N and this could be indicative of the presence of nutrient enrichment from human activities. It was also possible that the ammonia may have been in the process of being released through the decomposition of algae during the die-off of a bloom (Table 4).

Total phosphorus tested in August 1981 indicated a range in mean values from 0.04 mg/l in William and Adam Lakes to 0.07 mg/l in Sharpe Lake. The mean total phosphorus in Bower Lake was considerably higher at 0.17 mg/l. January, 1969 tests indicated a range in total phosphorus of from 0.03 mg/l in William and Sharpe Lakes to 0.07 mg/l in Bower Lake, with tests in all lakes except Lake Metigoshe (Howard, 1981). On June 16, 1969 total phosphorus on Lake Metigoshe was 0.04 µg/l. During the summer of 1979 mean total

phosphorus was 0.09 mg/l in Sharpe Lake (Beck and Hughes, 1979). As with ammonia, higher levels of phosphorus were found near the bottom of Bower Lake with 0.19 and 0.20 mg/l of total phosphorus noted at the midd e and bottom of the water column (Table 4). McKee and Wolfe (1963) note that more than 0.20 mg/l in ground or surface waters is indicative that some phosphorus of sewage origin is present. However, in this instance it is probable that some phosphorus may have been released from decomposing algae (Table 4).

Total and faecal coliform bacteria found in single subsurface samples taken at each lake are noted in Table 9. High counts of total and faecal coliforms were noted in Bower and Sharpe Lakes. The presence of these bacteria in Bower Lake, as with ammonia and phosphorus, would tend to indicate the presence of some sewage in the lake. The high coliform counts in the sample from Sharpe Lake should be noted for future reference since single samples cannot statistically confirm the presence or absence of faecal material.

TABLE 9: Total and Faecal Coliform Bacteria by MPN method, Turtle Mountain Lakes, August 11 and 12, 1981

Lake	Date	Coliforms/100ml (MPN)	
		Total	Faecal
William	August 11	4	4
Adam	August 11	0	0
Bower	August 11	23	15
Max	August 12	4	4
Sharpe	August 12	75	43
Metigoshe	August 12	9	0

CONCLUSIONS AND RECOMMENDATIONS

Since the data collected on the August 11 and 12, 1981 survey was of an abbreviated nature, and little relevant historical data was available, conclusions could not be drawn regarding specific reasons for unusually heavy growth of aquatic macrophyte (weeds) in Max Lake. As well, it could not be determined whether unusually dense weed growth had occurred in any of the other lakes examined. However, sewage may have been a nutrient source in Bower Lake and could be a potential problem in the other lakes.

1. Future meaningful studies on aquatic macrophytes would require intensive sampling to reach accurate conclusions.
2. If future water quality studies are carried out on Agro-Manitoba Lakes it would require seasonal collection of samples in order to determine temporal changes.
3. Chlorophyll and Secchi disc relationships should not be used as the sole indicator of trends in eutrophication since these relationships may be altered significantly by nutrient uptake in aquatic macrophytes.

POOR

QUALITY

ORIGINAL